

# PATENT COOPERATION TREATY

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## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 05PCT005MA	<b>FOR FURTHER ACTION</b>		See Form PCT/IPEA/416
International application No. PCT/JP2005/002955	International filing date (day/month/year) 17.02.2005	Priority date (day/month/year) 24.02.2004	
International Patent Classification (IPC) or national classification and IPC INV. F04C18/356 F04C29/08 F04C23/00			
Applicant MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD. et al.			
<p>1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 6 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> sent to the applicant and to the International Bureau) a total of 6 sheets, as follows:</p> <p><input checked="" type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</p> <p><input checked="" type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</p> <p>b. <input type="checkbox"/> (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in electronic form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>			
<p>4. This report contains indications relating to the following items:</p> <p><input checked="" type="checkbox"/> Box No. I Basis of the report</p> <p><input type="checkbox"/> Box No. II Priority</p> <p><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p><input type="checkbox"/> Box No. IV Lack of unity of invention</p> <p><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p><input checked="" type="checkbox"/> Box No. VI Certain documents cited</p> <p><input checked="" type="checkbox"/> Box No. VII Certain defects in the international application</p> <p><input type="checkbox"/> Box No. VIII Certain observations on the international application</p>			
Date of submission of the demand  19.12.2005		Date of completion of this report  30.03.2006	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized officer  Descoubes, P  Telephone No. +49 89 2399-7066	



**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/JP2005/002955

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**Box No. I Basis of the report**

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1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
- ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
- ☐ international search (under Rules 12.3 and 23.1(b))
  - ☐ publication of the international application (under Rule 12.4)
  - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements**\* of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report):*

**Description, Pages**

1-7, 12-33	as originally filed
8-11	filed with telefax on 17.02.2006

**Claims, Numbers**

1-7	filed with telefax on 17.02.2006
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**Drawings, Sheets**

1/17-17/17	as originally filed
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- ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing
3. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
  - ☐ the claims, Nos.
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to sequence listing (*specify*):
4. ☒ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
- ☐ the description, pages
  - ☒ the claims, Nos. 1
  - ☐ the drawings, sheets/figs
  - ☐ the sequence listing (*specify*):
  - ☐ any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT  
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**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

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1. Statement

Novelty (N)	Yes: Claims	4-7
	No: Claims	1-3
Inventive step (IS)	Yes: Claims	
	No: Claims	1-7
Industrial applicability (IA)	Yes: Claims	1-7
	No: Claims	

2. Citations and explanations (Rule 70.7):

**see separate sheet**

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**Box No. VI Certain documents cited**

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1. Certain published documents (Rule 70.10)

and /or

2. Non-written disclosures (Rule 70.9)

**see separate sheet**

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**Box No. VII Certain defects in the international application**

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The following defects in the form or contents of the international application have been noted:

**see separate sheet**

Reference is made to the following documents:

- D1: PATENT ABSTRACTS OF JAPAN vol. 2003, no. 12, 5 December 2003 (2003-12-05) -& JP 2004 197640 A (DAIKIN IND LTD), 15 July 2004 (2004-07-15)  
D2: US-A-4 826 409 (KOHAYAKAWA ET AL) 2 May 1989 (1989-05-02)  
D3: PATENT ABSTRACTS OF JAPAN vol. 015, no. 505 (M-1194), 20 December 1991 (1991-12-20) & JP 03 222884 A (MITSUBISHI ELECTRIC CORP), 1 October 1991 (1991-10-01)

1. The prior art document D1 published on 15.07.2004 claims the priority date of 18.12.2002. Its content as filed would therefore constitute relevant prior art for the purposes of Article 15(2) PCT if this prior art document had been published prior to the relevant date as defined in Rule 64(1) PCT.

The attention of the applicant is drawn to the fact that the content of this prior art document as filed will be considered as comprised in the state of the art relevant to the question of novelty, pursuant to Article 54(3) and (4) EPC once the present application will have entered the regional phase.

2. The amendments in claim 1 filed with the facsimile dated 17.02.2006 introduce subject-matter which extends beyond the content of the application as filed, contrary to Article 34(2)(b) PCT. The amendments concerned are the following: the expression "flow-in timing control means which controls the flow of the working fluid into the suction hole 10 in which the expander expends the working fluid" has been deleted from claim 1, which broaden the scope of protection of claim 1.  
**The following report is based on claim 1 in which this expression has been reintroduced.**
3. The present application does not meet the requirements of Article 33(2) PCT, since the subject-matter of independent claim 1 is not novel.

Prior art document D2 (see Fig. 1 and 2) discloses an expander comprising  
a cylinder 1,  
a shaft 2 having an eccentric portion 3,  
a roller 4 which is fitted to the eccentric portion and which eccentrically rotates inside  
the cylinder 1,  
a closing member 14, 15 for closing both end surfaces of the cylinder,  
a vane 5 for partitioning a space formed by the cylinder 1, the roller 4 and the closing  
member 14,15 into a plurality of working chambers,  
a suction hole 10 through which working fluid flows into the working chamber 1A,  
a discharge hole 11 through which the working fluid is discharged from the working  
chamber into a discharge space 9, and  
flow-in timing control means (*not shown*) which controls the flow of the working fluid  
into the suction hole 10 in which the expander expands the working fluid, and a  
discharge hole 11 through which the working fluid is discharged from the working  
chamber 1A into a discharge space 9, wherein the discharge hole 11 is provided with  
a differential pressure regulating valve 7 which is operated by a difference between  
pressure in the working chamber 1A and pressure in the discharge space 9.

Therefore, all the features of independent claim 1 are known from document D2.

4. Furthermore, document D3 taken independently of document D2 also discloses an expander with all the features of claim 1. Thus, this document also destroys the novelty of the subject-matter of claim 1.
5. The dependent claims 2-7 do not appear to contain any additional features which, in combination with the features of any claim to which they refer, could form subject-matter which is new and involves an inventive step (Art. 33(2) and Art. 33(3) PCT), the reasons being as follows:
  - 5.1 The additional features of dependent claims 2 and 3 are known from prior art document D2.

- 5.2 The additional features of dependent claims 4 to 6 appear to belong to the basic knowledge of a person skilled in the art.
- 5.3 The additional features of dependent claim 7 are known from prior art document D4.
6. The industrial applicability of the claimed subject-matter is self-evident.
7. The attention of the applicant is also drawn to the following:
- a) Contrary to the requirements of Rule 6.3 (b) PCT the independent claim is not properly cast in the two part form, with those features which in combination are part of the prior art being placed in the preamble.
  - b) Contrary to the requirements of Rule 6.2 (b) PCT the claims do not contain reference signs in parentheses. This applies to both the preamble and the characterising portion.
  - c) Contrary to the requirements of Rule 5.1 (a) ii) PCT, the documents D1 to D3 have not been acknowledged in the description.
  - d) Fig. 1 (describing the first embodiment) seems to be identical to Fig. 16 (illustrating the prior art)

for partitioning a space formed by the cylinder, the roller and the closing member into a plurality of working chambers, a suction hole through which working fluid flows into the working chamber, and a discharge hole through which the working fluid is discharged from the working chamber into a discharge space, wherein the discharge hole is provided with a differential pressure regulating valve which is operated by a difference between pressure in the working chamber and pressure in said discharge space.

With this aspect, even if the pressure in the discharge space is varied, the pressure in the working chamber and the pressure in the discharge space when the expansion stroke is completed can match with each other, and excessive expansion loss of the expander can be prevented. Especially, the excessive expansion loss can be prevented from being generated with an extremely simple structure that the differential pressure regulating valve is only added to the discharge hole of an expander. Thus, an efficient expander can be provided.

According to a second aspect of the invention, in the expander of the first aspect, the differential pressure regulating valve is closed when the pressure in the working chamber is lower than the pressure in the discharge space.

With this aspect, when the excessive expansion is generated in the expansion stroke, if the differential pressure regulating valve is closed to tightly close the working chamber, the working fluid in the working chamber is repressed, the excessive expansion loss can be prevented from being generated.

According to a third aspect of the invention, in the expander of the second aspect, the differential pressure regulating valve is a reed valve.

With this aspect, the differential pressure regulating valve is closed when the excessive expansion is generated. It is possible to constitute the differential pressure regulating valve extremely easily.

According to a fourth aspect of the invention, in the expander of the second aspect, the differential pressure regulating valve has a circular conical valve portion.

With this aspect, since the wasted volume caused by the discharge hole becomes small, deterioration in efficiency can be prevented.



According to a fifth aspect of the invention, in the expander of any one of the first to fourth aspects, fluid which expands from liquid phase or supercritical phase to gas-liquid two-phase is used as the working fluid.

When fluid expands from liquid phase or supercritical phase to gas-liquid two-phase, a specific volume of the working fluid is largely varied depending upon a ratio of gas and liquid and excessive expansion or incomplete expansion is prone to

be generated. According to this aspect, even when the excessive expansion or incomplete expansion is prone to be generated, it is possible to suppress the excessive expansion loss, and the efficiency of the expander can be enhanced.

According to a sixth aspect of the invention, in the expander of the fifth aspect, the expander is utilized in a heat pump cycle which uses carbon dioxide as the working fluid.

The carbon dioxide is environmentally friendly but a difference between high pressure and low pressure of the heat pump cycle is great, and even when the pressure ratio is slightly varied, a large excessive expansion loss is generated. With this aspect, the efficiency of a high pressure using the carbon dioxide can be enhanced.

According to a seventh aspect of the invention, in the expander of the sixth aspect, a shaft of the expander is directly connected to a shaft of a compressor used in the heat pump cycle.

With this aspect, excessive expansion when the expander is started can be prevented, no torque variation is generated. Therefore, the compressor of the heat pump cycle can efficiently and smoothly be started.

#### Brief Description of the Drawings

Fig. 1 is a vertical sectional view of an expander of a first embodiment of the present invention;

Fig. 2 is a transverse sectional view of the expander of the first embodiment of the invention;

Fig. 3 is a PV diagram of a working chamber of the expander of the first embodiment of the invention;

Fig. 4 is a transverse sectional view of an expander of a second embodiment of the invention;

Fig. 5 is a vertical sectional view of the expander of the second embodiment of the invention;

Fig. 6 is a vertical sectional view of an expander of a third embodiment of the invention;

## CLAIMS

1. (amended) An expander comprising a cylinder, a shaft having an eccentric portion, a roller which is fitted to said eccentric portion and which eccentrically rotates inside said cylinder, a closing member for closing both end surfaces of said cylinder, a vane for partitioning a space formed by said cylinder, said roller and said closing member into a plurality of working chambers, a suction hole through which working fluid flows into said working chamber, and a discharge hole through which the working fluid is discharged from said working chamber into a discharge space, wherein said discharge hole is provided with a differential pressure regulating valve which is operated by a difference between pressure in said working chamber and pressure in said discharge space.

2. (amended) The expander according to claim 1, wherein said differential pressure regulating valve is closed when the pressure in said working chamber is lower than the pressure in said discharge space.

3. (amended) The expander according to claim 2, wherein said differential pressure regulating valve is a reed valve.

4. (amended) The expander according to claim 2, wherein said differential pressure regulating valve has a circular conical valve portion.

5. (amended) The expander according to any one of claims 1 to 4, wherein fluid which expands from liquid phase or supercritical phase to gas-liquid two-phase is used as the working fluid.

6. (amended) The expander according to claim 5, wherein the expander is utilized in a heat pump cycle which uses carbon dioxide as the working fluid.

7. (amended) The expander according to claim 6, wherein a shaft of said expander is directly connected to a shaft of a compressor